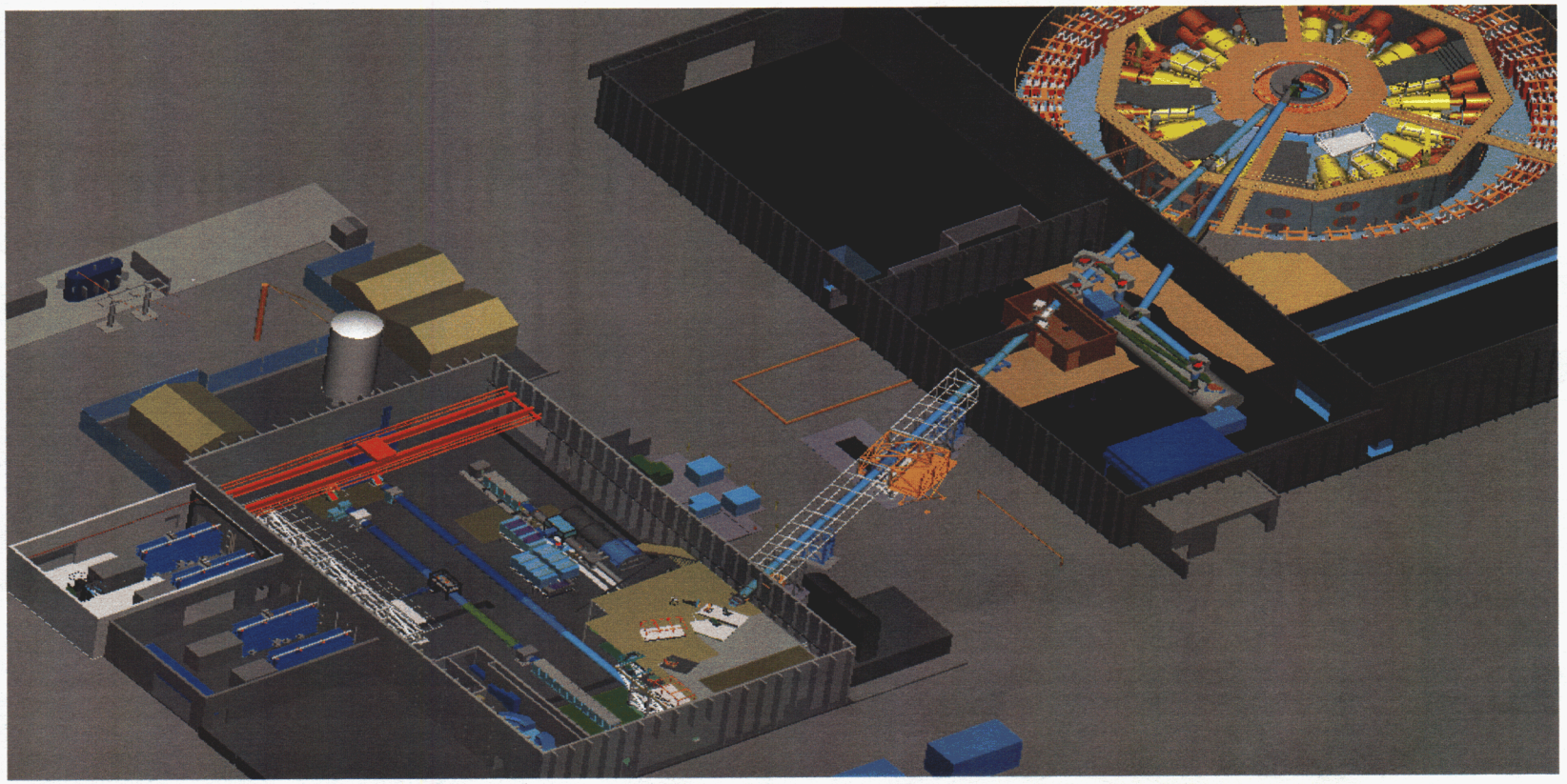
SAND2002-2998P

Z Beamlet enables backlighting experiments on Z

Z facility



Z Beamlet laser facility

Sandia is a multiprogram laboratory operated by Sandia Corporation, a Lockheed Martin Company, for the United States Department of Energy under contract DE-AC04-94AL85000.

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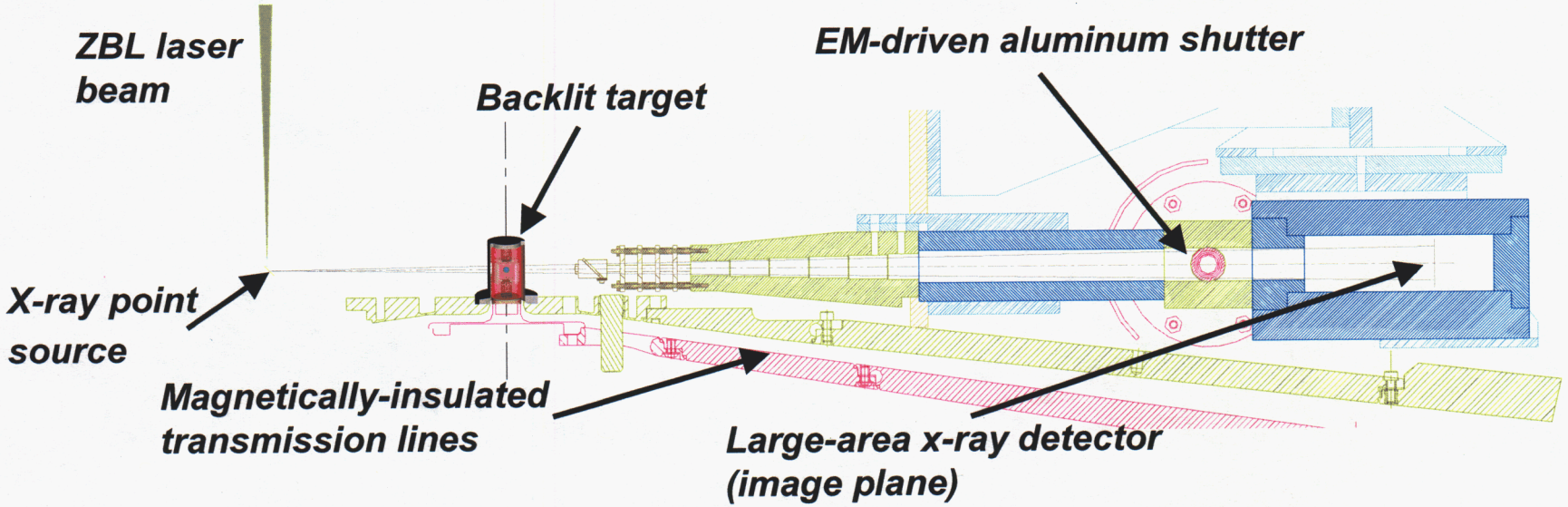
Z-Beamlet is now being used to x-ray image ICF capsules in z-pinch-driven hohlraums

During the fall of '98 Beamlet was dismantled at LLNL and shipped to Sandia.

The first experiments, Z shots 765-767, were performed during June 2001. The second backlighter series, Z826-839, occurred in Nov-Dec 2001. A third series is underway now.



Shielding / collimation reduces bremsstrahlung background to tolerable levels

EM-driven shutter successfully protects detector film/filter pack from debris

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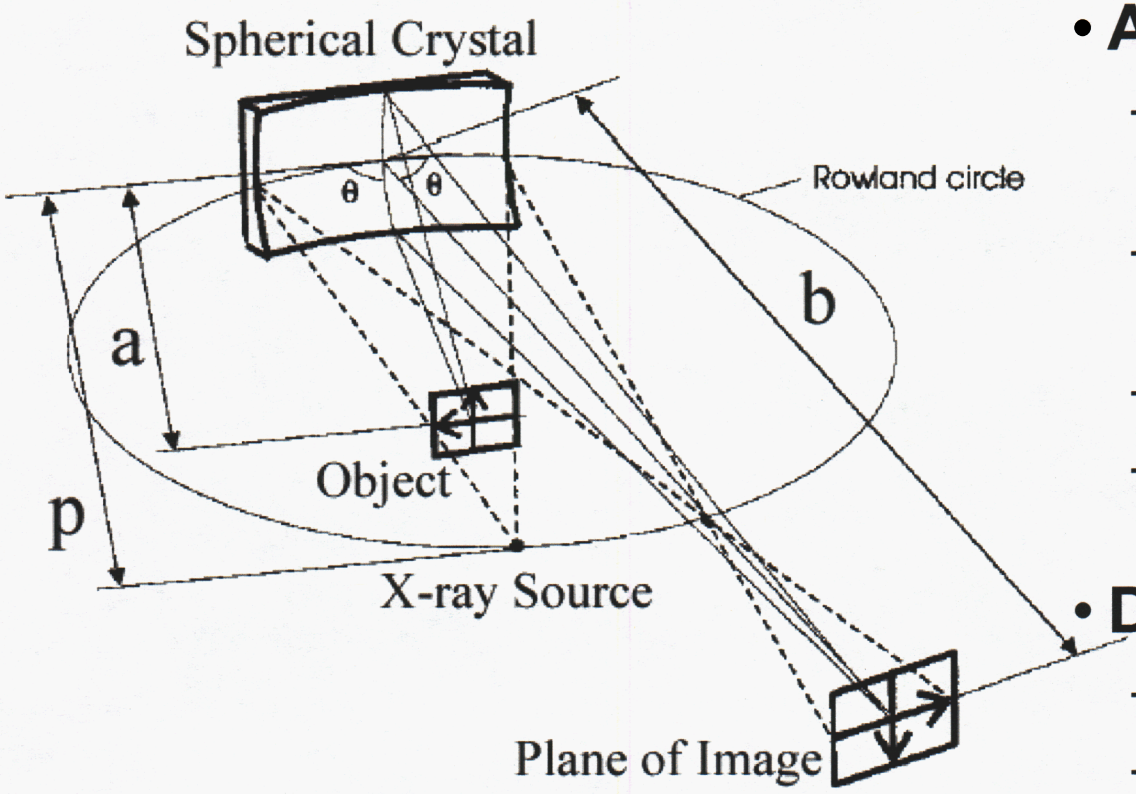
Bragg reflection off spherically bent crystals provides essentially monochromatic backlighting



- **Advantages**
  - Narrow spectral bandpass $\Delta E < .001$keV
  - avoids background radiation
  - <10 micron resolution
  - Large field of view (e.g. 20 mm by 5 mm)
- **Disadvantages**
  - More complex alignment
  - Crystal must be inside blast shield, likely to be destroyed each shot

S.A. Pikuz, *et al.,* JETP Lett. **61**, 638 (1995);

S.A. Pikuz, *et al.,* Rev. Sci. Instrum. **68**, 740 (1997).

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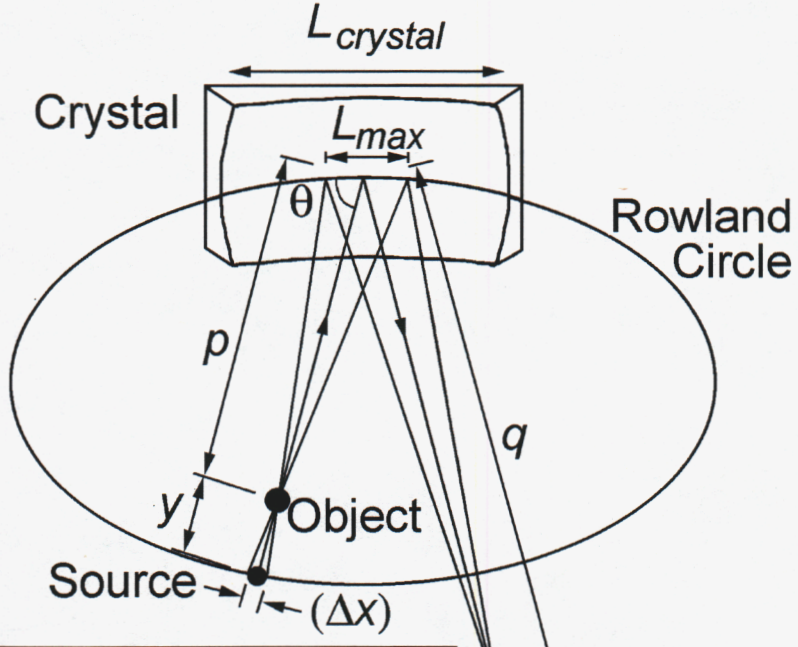
Image resolution is nearly independent of the x-ray source size



Object-to-crystal distance = *p*
Crystal-to-detector distance = *q*
Crystal bending radius = *R*
Rowland Circle radius = *R/2*

Detector position at focal position of the object:

$$1/p + 1/q = 2 / (R \sin\theta)$$

Field of view:

$$FOV = L_{crystal}\{y/(p+y)\}$$

Spectral bandpass:

$$\Delta\lambda/\lambda = (\Delta x/R)\cot(\theta)$$

Magnification:

$$M = q / p$$

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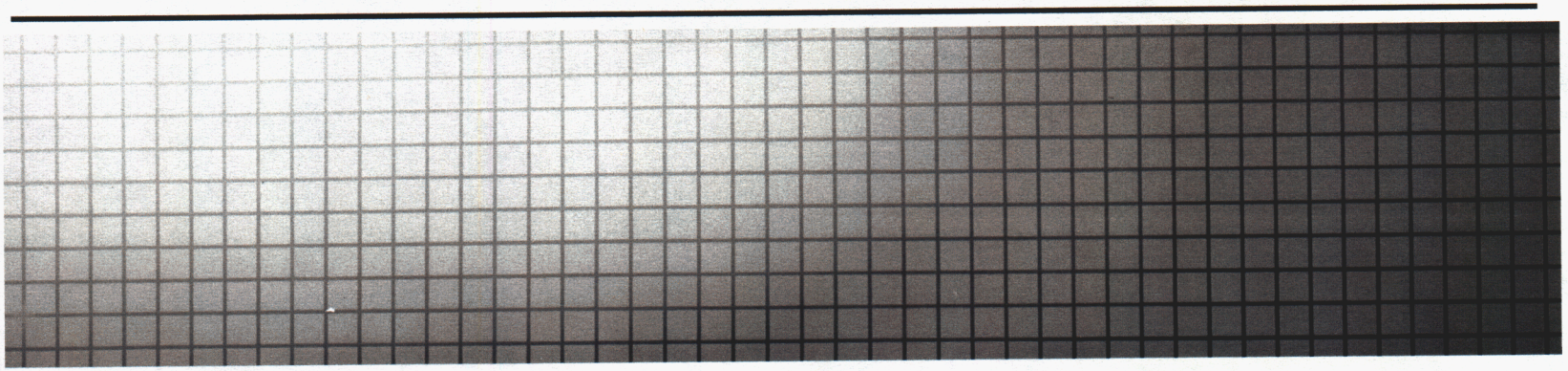
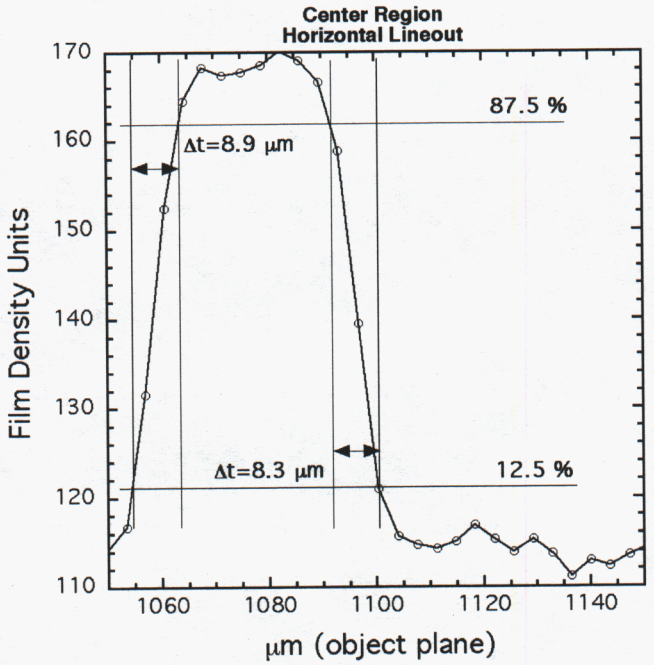
The 1.865 keV system was tested on the Z-Beamlet calibration chamber





- The Si He-α imaging system has been tested in the ZBL calibration chamber in a Z-identical geometry.
- Images of 33.5 μm diameter electroformed meshes have been obtained with ~10 μm resolution.

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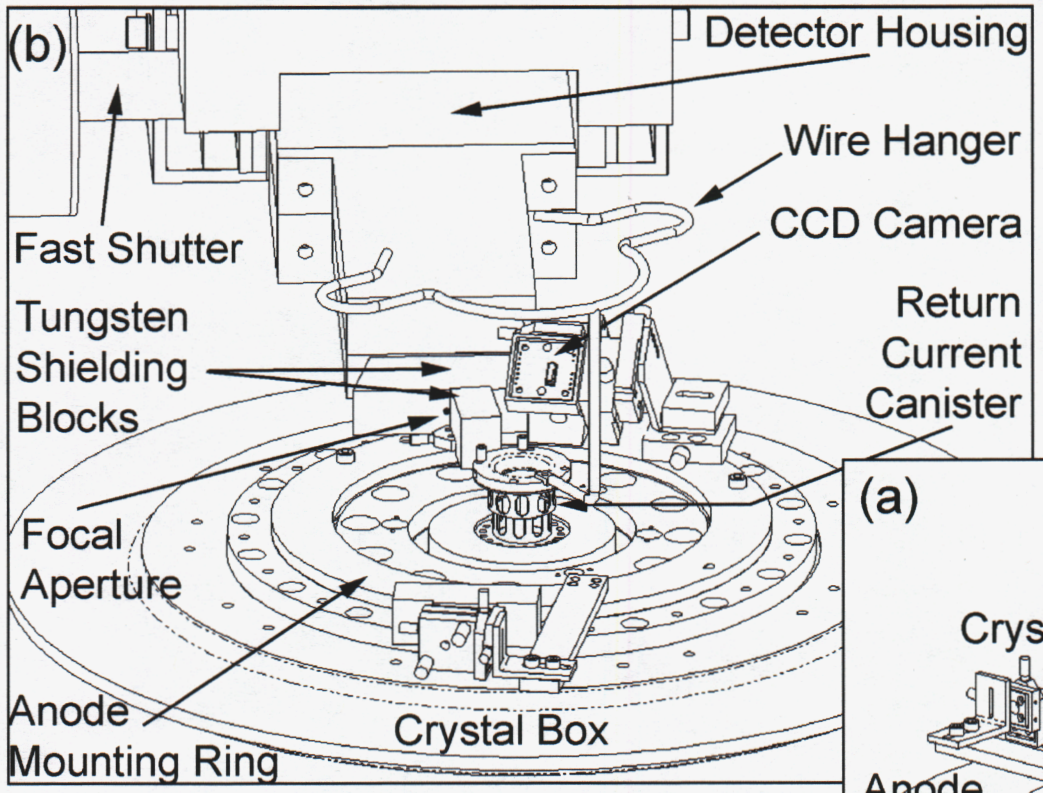
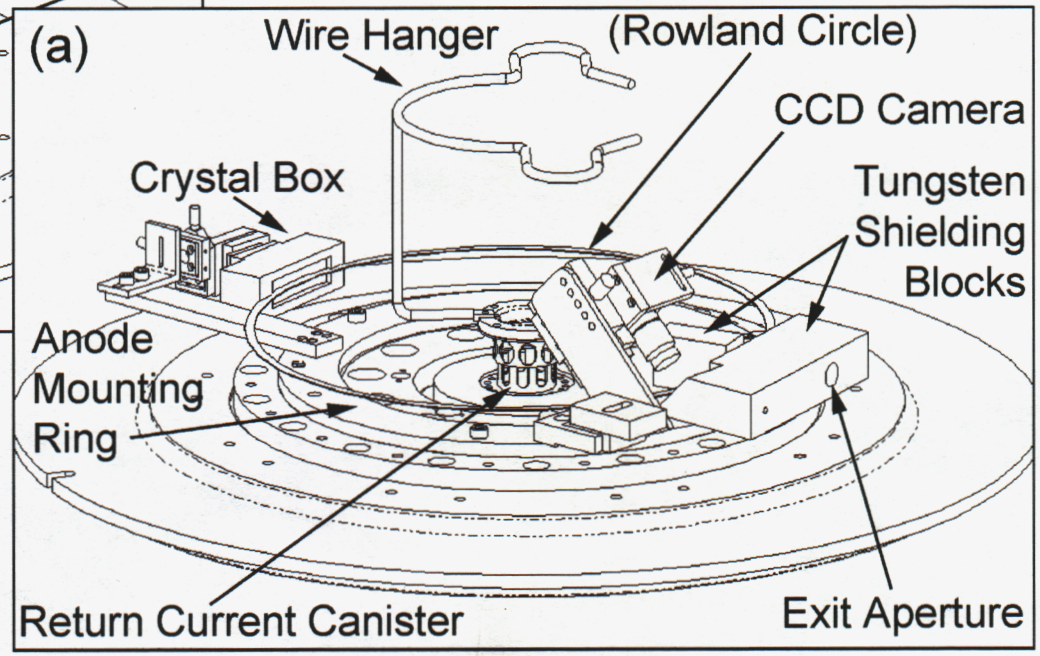
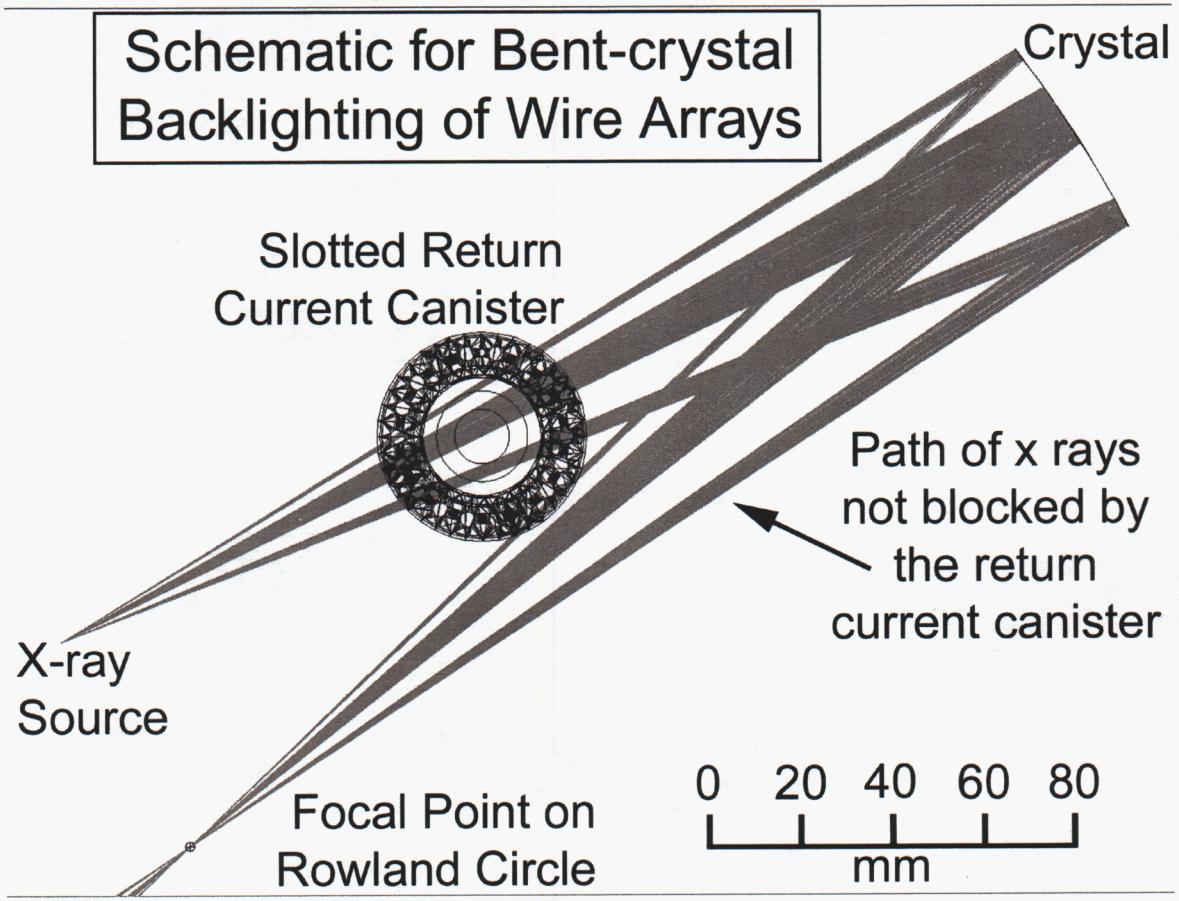
Schematic of Monochromatic X-ray Backlighting System on Z





This hardware will be fielded next on 3 shots in September and 7 shots during October 2002.

Field of View for June Z Shots



- 20 and/or 12 mm diameter wire arrays will be fielded.
- The unblocked field of view of the crystal is 20 mm.
- View of pinch at stagnation will be blocked using Au foil.

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X-ray backlighting of the wire array was attempted on two shots

- Two-dimensional ("r-z"), monochromatic x-ray backlighting was used during Z931 and Z932 to look at the motion of the wire array.
- The x-ray source was a Si target illuminated by the Z-Beamlet laser. The Si He_{α} line at 1.865 keV was used as the backlighter source.
- These shots were the first tests of a bent-crystal radiography system on the Z-machine.
- Partial success: an image was obtained on Z931 but not on Z932—crystal heating likely to blame.

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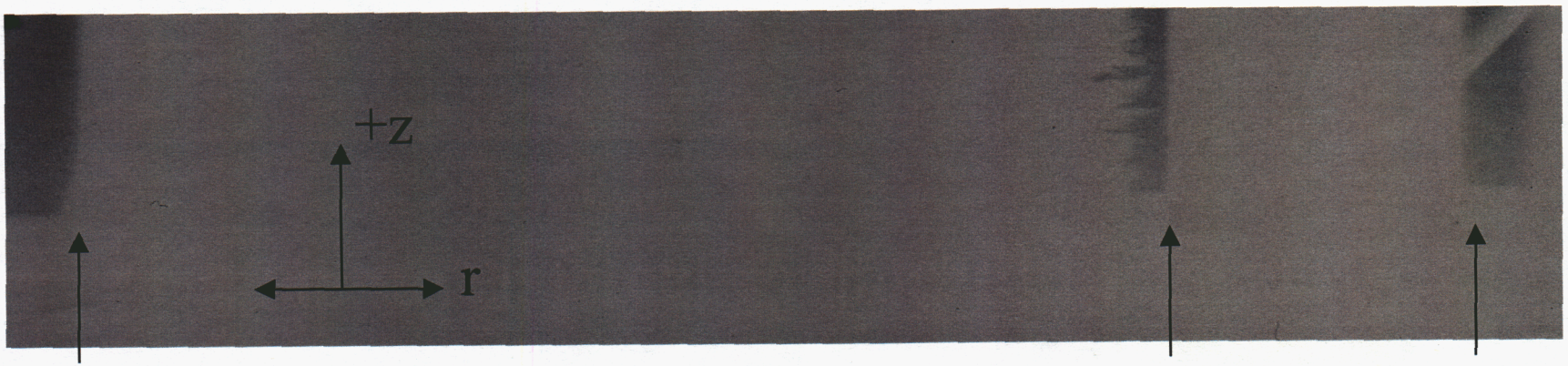
Bent-Crystal Radiography (BCR) Results



r = -5.85 mm

r = +6.05 mm r = +9.00 mm

Radiography film from Z931: A single, 12 mm diameter, 15 mg/cm, 180 W wire array. RAK gap was very large—9 mm! (7.5 mm slot width)

Only one of the three fields of view through the return-current can was expected to contain data.

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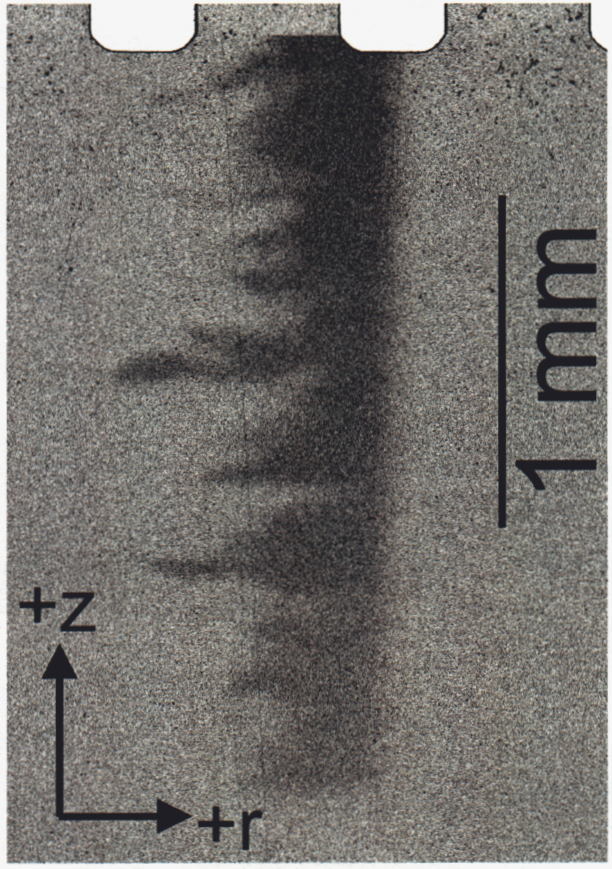
Boundary of wire-array mass visible through center slot

Radial location of outer slot edge determined using ray-tracing to be 6.05 mm +/- 0.15 mm.

Complex axial structure is clearly visible. FFT analysis shows that the dominant wavelength is 304 μm, but there were also peaks at 234, 176, 141, and perhaps 66 μm. Are these harmonics of a 60 μm wavelength?

Contrast is poor compared to ZBL tests of backlighter. Believe crystal heating is responsible.

1/e attenuation of 1.865 keV x rays in W at 10^{18} atoms/cm^2, or 0.305 mg/cm^2. Wire array was 15 mg.



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